The values of Cmax are determined by inspection and the values for bioavailability (relative to an intravenous injection) are calculated from the areas under the curve that were obtained from plots of plasma sCT concentration as a function of time.

EXAMPLE 1

The following study examines the effect of the concentration of citric acid on the bioavailability and plasma concentration of nasally administered salmon calcitonin. Rats were administered intranasally as described previously 20 μl of rsCT (200 μg/ml) in 0.85% sodium chloride, 0.1% TWEEN® 80, 0.2% phenylethyl alcohol, 0.5% benzyl alcohol and varying amounts of citric acid adjusted to pH 3.7 at t=0, 20, 60 and 90 minutes. Samples of blood were taken prior to the administration of rsCT at these time points as well as at t=120 and 150 minutes. The resulting plasma samples were analyzed for rsCT by radioimmunoassay. Maximum rsCT levels were detected at t=120 minutes. The results of this study as shown in Table 1 indicate that the bioavailability and peak concentration of rsCT was a function of the concentration of citric acid in the formulation.

TABLE 1

EFFECT OF THE CONCENTRATION OF CITRIC ACID ON THE BIOAVAILABILITY AND PLASMA CONCENTRATION OF SALMON CALCITONIN ADMINISTERED INTRANASALLY TO RATS

Citric acid (pH 3.7)	Bioavailability (percent ± sdev)	Maximum plasma sCT (ng/ml ± sdev)
0	0.89 ± 0.19	1.10 ± 0.52
10	3.14 ± 1.77	3.66 ± 1.67
25	5.01 ± 2.34	5.11 ± 2.09
50	6.15 ± 1.31	6.05 ± 1.30
100	13.36 ± 3.38	12.98 ± 3.96

EXAMPLE 2

The following study examines the effect of different preservatives on the plasma concentration of nasally administered salmon calcitonin. Rats were administered intranasally as described previously 20 μl of sCT (200 μg/ml) in 0.85% sodium chloride, 0.1% TWEEN® 80 and a combination preservatives of either 0.2% phenylethyl alcohol and 0.5% benzyl alcohol or 0.27% methyl parabens and 0.04% propyl parabens at t=0, 30, 60 and 90 minutes. The results of this study as shown in Table 2 indicate that the bioavailability and peak concentration of rsCT are not significantly affected by the addition of the different preservatives.

TABLE 2

EFFECT OF PRESERVATIVES ON THE AVAILABILITY AND PLASMA CONCENTRATION OF SCT ADMINISTERED INTRANASALLY TO RATS

Preservatives	Bioavailability (percent ± sdev)	Maximum plasma sCT (ng/ml ± sdev)
None	1.14 ± 0.87	1.24 ± 0.79
0.2% phenylethyl alcohol - 0.5% benzyl alcohol	0.89 ± 0.19	1.10 ± 0.52
0.27 methyl parabens - 0.04% propyl parabens	1.08 ± 0.86	1.47 ± 1.46

EXAMPLE 3

The following study examines the effect of the concentration of citric acid on the stability of salmon calcitonin stored for varying periods at a temperature of 50° C. Nasal formulations containing sCT (200 μg/ml), 0.25% phenylethyl alcohol, 0.5% benzyl alcohol and 0.1% TWEEN® 80 were adjusted to pH 3.7 with either HCl or the indicated amount of buffered citric acid. The formulations were stored at 50° C. in sealed glass containers for the indicated amount of time and analyzed for sCT by high performance liquid chromatography. The results as shown in Table 3 indicate that in the absence of citric acid, the amount sCT in the formulation decreased steadily between 0 and 9 days after the study was begun. In the presence of citric acid (10–50 mM) the rate of disappearance of sCT decreased significantly. However, as the concentration of citric acid was further increased, the rate of sCT disappearance from vials stored at 50° C. increased in proportion to the amount of buffered citric acid in the formulation.

TABLE 3

EFFECT OF THE CONCENTRATION OF CITRIC ACID ON THE STABILITY OF sCT STORED FOR VARYING PERIODS AT 50° C.

	Percent sCT Recovered				
Citric Acid (pH 3.7)	0 mM	10 mM	20 mM	50 mM	100 mM
Days at 50° C.					
0	100	100	100	100	100
3	83	94	91	90	87
6	53	90	87	83	77
9	24	82	78	73	66
15	22	74	68	61	20

What is claimed is:

1. A liquid pharmaceutical composition comprising calcitonin or an acid addition salt thereof and citric acid and/or salt thereof in a concentration from 10 to about 50 mM, said composition being in a form suitable for nasal administration.

2. The liquid pharmaceutical composition of claim 1 further comprising a pharmaceutically acceptable, aqueous liquid nasal carrier.

3. The liquid pharmaceutical composition of claim 2, wherein said carrier comprises aqueous saline.

4. The liquid pharmaceutical composition of claim 1, wherein said composition is in the form of a nasal spray.

5. The liquid pharmaceutical composition of claim 4 having a viscosity of less than 0.98 cP.

6. The liquid pharmaceutical composition of claim 1, wherein the calcitonin is selected from the group consisting of salmon calcitonin, human calcitonin, porcine calcitonin and 1,7-Asu-eel calcitonin.

7. The liquid pharmaceutical composition of claim 1, wherein the calcitonin is salmon calcitonin.

8. The liquid pharmaceutical composition of claim 1, wherein said calcitonin, or salt is present in an amount of from about 100 to about 8,000 MRC units/ml.

9. The liquid pharmaceutical composition of claim 1, wherein said calcitonin, or salt is present in an amount of from about 500 to about 4,000 MRC units/ml.

10. The liquid pharmaceutical composition of claim 1, wherein said calcitonin, or salt is present in an amount of from about 500 to about 3,000 MRC units/ml.

11. The liquid pharmaceutical composition of claim 1, wherein said calcitonin, or salt is present in an amount of from about 1,000 to about 2,500 MRC units/ml.

12. The liquid pharmaceutical composition of claim 1 having a pH of from about 3 to about 5.

13. The liquid pharmaceutical composition of claim 1 having a pH of from about 3.5 to about 3.9.

14. The liquid pharmaceutical composition of claim 1 having a pH of about 3.7.

15. The liquid pharmaceutical composition of claim 1 having an osmotic pressure of from about 250 to about 350 mOsm/liter.

16. The liquid pharmaceutical composition of claim 1 further containing at least 0.1% by weight of polyoxyethylene(20) sorbitan monooleate.

17. The liquid pharmaceutical composition of claim 1 further containing at least one preservative selected from the group consisting of benzyl alcohol, phenylethyl alcohol, methyl parabens, ethyl parabens, propyl parabens and butyl parabens.

18. A liquid pharmaceutical composition comprising about 2,200 MRC units of salmon calcitonin, about 10 mM citric acid, about 0.2% phenylethyl alcohol, about 0.5% benzyl alcohol, and about 0.1% polyoxyethylene(20) sorbitan monooleate.

19. A liquid pharmaceutical composition comprising about 2,200 MIC units of salmon calcitonin, about 20 mM citric acid, about 0.2% phenylethyl alcohol, about 0.5% benzyl alcohol, and about 0.1% polyoxyethylene(20) sorbitan monooleate.

20. A method of administering a calcitonin to a subject requiring calcitonin treatment, which method comprises administering to said subject a composition as defined in claim 1 via the nasal route.

21. The method of claim 20, wherein the amount of calcitonin administered is from about 200 to about 600 MRC units.

22. A method of improving the stability of a liquid pharmaceutical composition of calcitonin comprising adding citric acid or a salt thereof in a concentration from 10 to about 50 mM to said composition.

23. A method of improving the bioavailability or the concentration of plasma calcitonin in a subject following nasal administration of a liquid pharmaceutical composition of calcitonin, which method comprises adding citric acid or a salt thereof in a concentration from 10 to about 50 mM to said composition prior to said administration.

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